SSC Atlantic

SPAWAR
Systems Center
ATLANTIC

Technology Strategy

September 30, 2016

Andrew Mansfield
Engineering Competency Lead (5.0), SSC Atlantic

Dr. Al Emondi
S&T Competency Lead (7.0), SSC Atlantic
Deputy CTO, SSC Atlantic

Table of Contents

Overview

SPAWAR Systems Center (SSC) Atlantic is a member of the Naval Research & Development Establishment (NR&DE). The NR&DE is comprised of all Navy warfare centers, systems centers and laboratories, equipped with world-class scientists and engineers uniquely qualified to introduce solutions to complex naval warfighting problems. The NR&DE is positioned to leverage established relationships across all of its members -- federally funded research and development centers (FFRDC), academia, small businesses and the broader defense industry -- to execute our rapid prototype efforts, and to collaborate on advanced technologies. As a member of this establishment, our strengths and capabilities will be aligned to NR&DE goals. We will leverage NR&DE relationships to advance the body of knowledge in the technologies outlined in this strategy across the Navy, and to leverage workforce and solutions wherever they may reside.

SSC Atlantic delivers information warfare solutions to enable Warfighters to secure America and promote global freedom. The command's information warfare mission requires expertise in a variety of enabling technologies, skillsets and laboratory infrastructure. This is critical to our ability to offer the best solutions to the Warfighter. The technologies we use to develop these capabilities advance at an exponential rate. We must address the need to implement these technologies effectively and integrate them across a spectrum of naval applications by shaping our organization to adeptly support our Warfighters.

Our budget is limited, and not all of our workforce demand signals today align to our technical priorities. Therefore, we must be prudent about our investments and strategic involvement in technology areas that are relevant to naval needs in our areas of expertise. The technology strategy outlined in this document, coupled with our business development strategy, will guide our other strategic initiatives. It will provide direction for our external work acceptance and internal innovation programs, and will be a valuable communication tool to our workforce and outside customers about our work and expertise.

Purpose

SSC Atlantic's role is to provide capabilities that use leading-edge technology in innovative ways to outpace the threat of our adversaries. The SSC Atlantic Technology strategy provides a roadmap to equip our workforce with knowledge, skills, abilities and resources (e.g., tools, labs) to apply these technologies to the solutions we provide to the Warfighter. We will harness our existing expertise and aptitude and build new capability in advanced technologies relevant to Warfighter needs and operations. Our current and future work will place technical demands on our organization that must be anticipated and planned for in order to ensure we can respond to the needs of the fleet today and in the future. To ensure our technology strategy is appropriately positioned, internal and external influences were considered, as well as technology predictors and resource sponsor roadmaps. The current demands on the organization, as well as the portfolio business thrust areas, helped define the nearer term tactical requirements that are currently applying pressure on our workforce and infrastructure.

Internal Considerations

This technology strategy is a critical component of a more holistic business strategy that supports the use and advancement of modern technology and technical execution approaches. Much of our current business involves our technical personnel after the project has been defined. Often our technical staff is used to provide technical oversight of contracts with minimal involvement in early project planning and design phases of programs. With the proper skills and programmatic emphasis, SSC Atlantic scientists and

engineers will be provided opportunities to influence acquisition programs early in the project's conception. This will enable our technical workforce to offer insight and advice in technology innovations, solutions, design patterns and best practices. Due to the natural delays in staffing and laboratory infrastructure, this strategy attempts to get ahead of the demand in a much more predictable manner.

To achieve our stated goals, it is imperative that we evolve and shape our organization with purpose. Clearly, we are stronger in some areas in this strategy than others. As we baseline our strengths, we will focus on bringing all of our technical capabilities to our targets. This plan will guide our Naval Innovative Science & Engineering (NISE)/Innovation and other internal discretionary investments, our competency development models (CDM) and workforce development models (WDM), training/education opportunities and hiring goals. It will also drive work acceptance and lab/facility infrastructure allocations.

External Considerations

As discussed above, how we engage with the NR&DE is essential to the management and execution of our technology strategy. We will coordinate directly with the NR&DE leadership (e.g., Naval Laboratory/Center Coordination Group (NLCCG)) to ensure that we communicate our technology priorities and coordinate with other members of the establishment. As part of this effort, we will identify critical prototyping efforts for which we could add resources and/or solutions, as well as identify and promote prototypes that we could initiate.

Regarding external drivers of the technology strategy, we recognize that as the Department of Defense (DoD) emerges from 13 years of war, budget realignments and shifting priorities are affecting our primary sponsors, and thus our work. Significant attention in the Defense Innovation Initiative is now creating offset strategies that are intended to create new overwhelming capability in our Nation's military. Investments are anticipated in technologies that are squarely within the SSC Atlantic mission of C4ISR. Particularly, growth is projected in anti-area/access-denial technologies, human-machine collaboration, assisted decision, cyber and electromagnetic warfare, advanced data analytics and additive manufacturing. Emerging technologies implemented on new and existing systems will create competitive advantages and new warfighting concepts. While previous offset strategies relied solely on new technology superiority, this offset strategy will depend on a combination of new and existing technologies, and on new and existing warfighting concepts. The unique capabilities of SSC Atlantic, operating across the science and engineering spectrum, uniquely position us to explore technologies for new and legacy systems, and offer a unique opportunity to bring new research and strong engineering capability together in novel, innovative ways.

A significant component of our future success is our ability to support today's mission and maintain expertise on existing naval systems. A robust and thorough understanding of our legacy systems and a forward-leaning innovative workforce will ensure SSC Atlantic is postured to provide relevant laboratory capability well into the future. As we continue to strengthen our alignment to our sponsors' technical needs today, we must prepare for tomorrow's anticipated demands. It is imperative that we choose and execute a business strategy that will provide the best leverage to build critical capabilities for tomorrow. We must be mindful and deliberate in how we select and complete projects so we create key skillsets in technology areas for future requirements. Our work must also strike the right balance of representative skills across the engineering life cycle. This technology strategy provides the basis to ensure we are accepting and conducting work that will correctly position SSC Atlantic as a premier information warfare solutions provider.

Technology Growth Areas

Introduction of Technology Growth Area (TGA) Approach

Operating from the context of the SSC Atlantic mission, the technology guidance presented in this document is developed from two major perspectives: technology needs and technology availability. Naval needs are primarily assessed using overarching DoD and naval strategic plans, investment budgets and formal naval needs and gaps statements. Available and emerging technologies are evaluated using a significant literature review and consideration of technology adoption in commercial markets (figure 1). Using this approach, it is possible to predict technology, skillsets and laboratory capabilities that are needed to support the Warfighter now and in the foreseeable future.

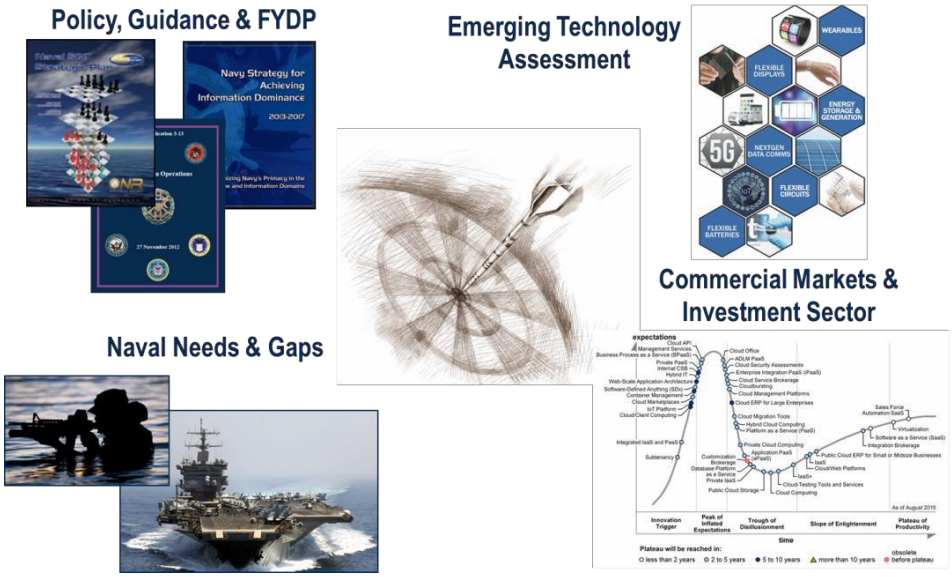

Figure 1: SSC Atlantic's technical priorities are derived from DoD guidance, naval needs, emerging technologies and commercial momentum.

While DoD and Department of the Navy strategies encompass many technology areas, not all are well aligned to the information warfare mission of our organization. This strategic document focuses on enabling technologies that are relevant to the SSC Atlantic mission and are anticipated to play a significant role in current and future naval systems. To gain an understanding of naval needs, various requirements and technology gaps were studied, as well as strategic roadmaps from various resource sponsors. Numerous research and technology publications were also studied to determine the current state of the art and maturity of relevant technologies. While an overall technology growth area is quite broad, the following descriptions attempt to decompose focus areas into more succinct technologies that have relevance to science and engineering.

Overview of Specific Technology Growth Areas

As a solution provider of technical expertise and services, it is imperative that our leadership practices achieve the necessary balance of technical personnel, laboratory infrastructure, work acceptance, and contract augmentation. This will enable growth in relevant technical areas while meeting current portfolio demand. Various steering committees under the business board are responsible for ensuring processes, metrics, and expectation thresholds are established to assess progress in achieving

these goals. Based on the studies referenced in figure 1, some technology growth areas are currently, or projected to be, of significant importance to our naval customers. The TGAs are intended to be broad and overarching in a given functional area. They will therefore facilitate current work alignment without creating significant exceptions where alignment may not exist. Using broad TGA definitions also minimizes the number of TGAs for ease of understanding and usefulness. The TGAs are introduced and defined below.

Cyber Warfare

The cyber warfare TGA is perhaps the most broadly defined and includes the subcategories of information technology (IT) in a security context: design, development, validation, assessment/testing, deployment, and operations (i.e., attack, defense, exploitation, intelligence). This category includes defensive and offensive technologies used to operate, configure, control, secure, maintain, or restore infrastructures and resident data. This includes IP networks, RF networks, computer systems, embedded processors and controllers, process, and physical systems. There are a wealth of technologies and capabilities that are used in this domain (including other TGAs.) Examples include the protection of information on single and multilevel systems, identity management and forensics. Cyber warfare ensures availability, integrity, authentication, confidentiality and nonrepudiation of data sources. The figure 2 represents a thought model outlining the challenges of Cyber in a security/operational command, control, communications, computers, combat Systems, intelligence, surveillance and reconnaissance (C5ISR) framework.

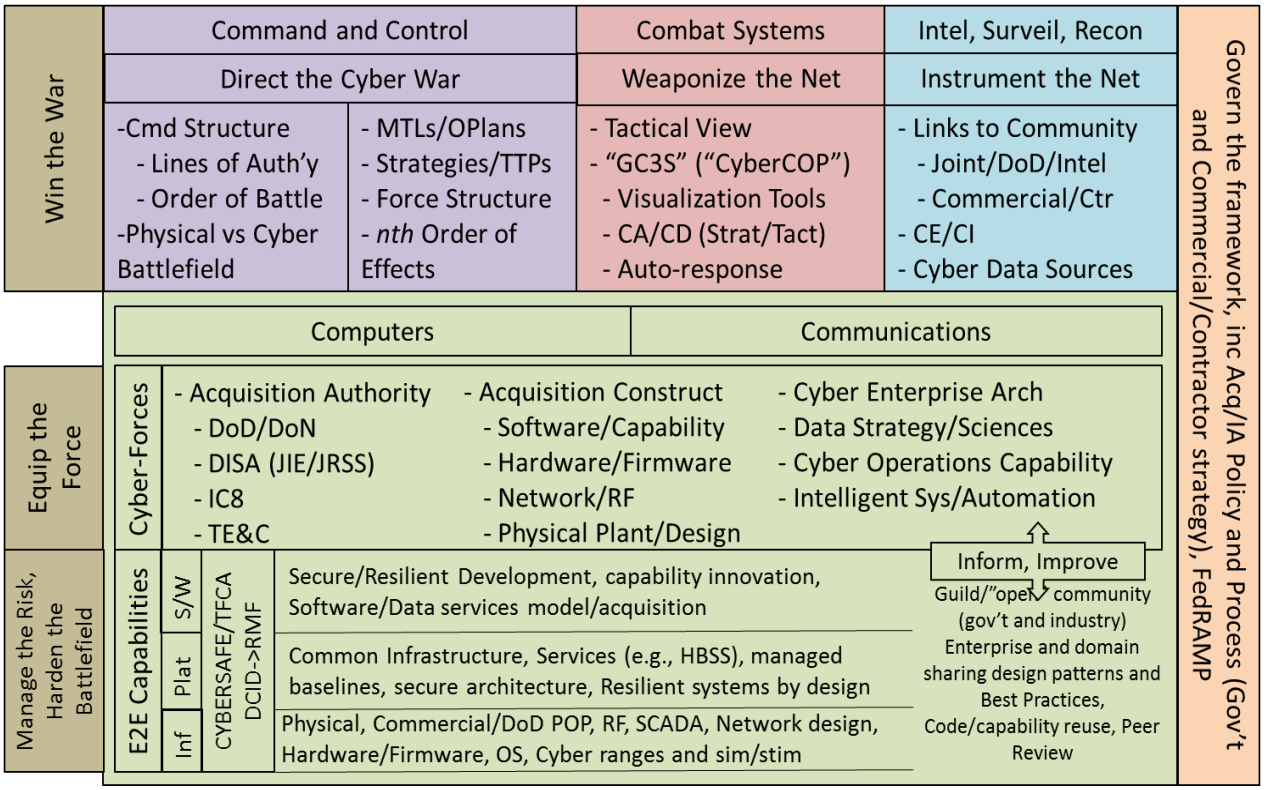

Figure 2: Cyber C5ISR Framework

Data Science/Analytics

This TGA includes technologies that enable access and management of large quantities of data in structured and unstructured forms. The data includes access to real time, near real time, and stored information to derive value. This technology area includes innovative forms of information processing and analytics to provide insight into a data-driven complex solution space. Technologies also include approaches for data storage, proliferation, retrieval, and replication. Data sciences/analytics involve data and metadata structures, algorithms and behavior, which store, process, access, and communicate information. Data sciences/analytics also include advanced approaches in data organization, deep/machine learning, artificial intelligence, and data visualization.

Assured Communications

This TGA addresses the increasing demand for voice, multimedia, and data transmission through wired and wireless communications systems. The assured communications area of interest focuses on technologies that explore transmission methods and datalinks, enabling greater information bandwidth, increased security, range, and power efficiency. Exploitation of unused radio spectrum and development of RF sensing capability will be essential in promoting multiband dynamic spectrum agility. Advanced modulation and spread spectrum techniques, as well as low probability of intercept (LPI), low probability of detection (LPD), electromagnetic countermeasures (ECM) resistance approaches, are of particular interest. Technologies will include application in multiple transmission spectrums (RF, millimeter wave & optical). This focus area includes networking technologies that promote stable and efficient networks. Networking techniques such as application awareness, resilient routing and attack tolerance (supporting Cyber Warfare TGA) are included as a part of this technology focus.

Cloud Computing/Big Data

As IT service models (e.g., "cloud") continue to evolve and are embraced by the DoD, their use in mission-critical operations will become more prevalent. Cost savings, agility, innovation, and the strategic use of cloud for IT modernization and digital transformation will be realized through the implementation and use of resilient infrastructure, platform and software services. Coupling DevOps processes and continuous deployment capabilities with emerging cloud vendors will provide greater capability and speed to operations for our customers at a further reduced cost. Cloud solutions will also have their impact on mobility (see Mobility TGA) and will likely have a platform role in orchestrating big data, multiple sensors and devices that are connected to the cloud (a.k.a. "Internet of Things.") The science and engineering workforce will require proficiency in popular software tools/capabilities such as VMWare/Virtustream, Amazon Web Services, Spinnaker, OpenStack, Microsoft Azure and Google App Engine.

Enterprise Resource Tools

Generally our Enterprise Resource Planning (ERP) technical work can be divided into two categories. The first is any task supporting a major commercial ERP system (i.e., SAP, Oracle eBusiness Suite, PeopleSoft, Epicor, Infor, Microsoft Dynamic ERP). The second is any task supporting a custom solution that will be supporting business/logistics decision support systems across an entire enterprise (e.g., Navy Tactical Command Support System (NTCSS)). We will continue to grow our workforce to support tasking across the software life cycle, to include operations support. This TGA is perhaps the most difficult to manage. It requires a broad range and mix of expertise to even include the integration of credentials and skillsets such as commercial software certifications, software development, system administration and configuration activities, and business process engineering.

Collaboration/Social Networks

Commercial industry and social communities have grown well beyond forums and documents. Social networking technologies are maturing and becoming even more tightly integrated into day-to-day operations. The Navy has already embraced "ChatOps" (i.e., integration of open-source chat capabilities into their operations over naval messages), and it is imperative that we engage to be the leaders in this maturing TGA. We must inculcate collaboration and social interaction for sharing design patterns and best practices into our engineering culture, as well as incorporate those supporting capabilities into the systems we deliver. The technologies of this TGA allow social interaction to be aggregated, assessed, and pushed back into the supporting systems as structured data that can be used to support better decision-making. The current technology drivers are pushing systems to become more natural and making socially produced information more available. Technical work in this area may cover any task supporting a major commercial or open source system, e.g., Slack, Jabber, SharePoint, Yammer, MediaWiki or any task supporting a custom solution that provides social networking/Collaborative Technology capabilities.

Autonomy

The Autonomy TGA covers the techniques that can be applied to systems, enabling them to adapt their actions to changes in their mission and operating environment without the intervention of a human operator. This TGA incorporates assistance and decision support systems implemented through artificial intelligence and machine learning as part of this definition. Autonomous systems typically use embedded sensors and onboard preprocessing to survey the environment and make course changes or changes to their initial objective based on the situation they encounter. Challenges in this TGA also include technologies to thwart against autonomous systems such as small form factor detection. Autonomy in our context is extended beyond the typical UxV construct and broadened to include autonomous artificial intelligence systems, assisted decision aids and information aggregators/advisors. It also includes algorithm and control mechanisms in support of swarming, multipath or best-path analysis.

Embedded Systems

The Embedded Systems TGA encompasses computer systems that perform a particular function within a larger system without direct human interactions. Operation of these systems is often in real time. Due to this demanding, small form factor implementation, processor throughput, memory management, and power-efficient software implementation are critical. A specialized understanding is required in the use of Field-Programmable Gate Arrays (FPGAs), Digital Signal Processors (DSPs) and Advanced Reduced Instruction Set Computer (RISC) Machines (ARMs), either individually or in conjunction with each other or with General-Purpose Processors (GPPs). Efficient memory use and programming practices will require the ability to develop application code often tailored to reduce the number of processor cycles. Embedded systems are robust and must often perform their functions in forward-deployed, remote and energy-sparse locations. As a result, energy generation and harvesting are often part of the integrated system as well as onboard advanced sensor packages.

Mobility

The Mobility TGA in a naval context is more than just the incorporation of mobile phones, tablets, and laptops as fully functional clients in the enterprise. It also focuses on providing solutions that provide the Warfighter the ability to engage with a dynamic mobile environment anytime and anyplace. The realization of effective mobility solutions is strongly dependent on other TGAs such as cyber, embedded systems, and assured communications. This TGA includes the wireless technology and

infrastructure to connect and authenticate to the enterprise while enforcing enterprise specific security policies on mobile devices to access enterprise data. Interest areas are composed of the following: communication infrastructure (3G, 4G LTE, 5G, 802.11x, etc.), network infrastructure (routers, switches, firewalls, etc.), mobile devices (smart phones, tables, laptops, etc.), mobile device managers (MDMs), identity management, network access and authentication, software development (e.g., Android, iOS), device security, localization and power systems/sources.

Existing Technology Areas

The above TGAs are presented based on an understanding of future requirements and leading/maturing technologies and IT service models. They are not meant to minimize other technology areas that the command is already heavily invested in as part of delivery of capability to our customers. We will continually evolve and develop our skills in these technology domains.

Governance

Assertion of Technology Growth Areas in Work Shaping

Guidance in this technology strategy will be used to develop metrics and thresholds in our work shaping exercises to achieve a project acceptance approach. This approach will increase technical work while supporting the necessary components of logistics and program management across the project life cycle. Considering our current work baseline, the technology strategy provides guidance for increasing our technical effort on projects that are well aligned to our command's technical priorities. An assessment of our current projects -- and skillsets utilized to execute them -- provides insight to our current workload distribution (see Appendix). It is evident that our current work effort in many technical priority areas does not have adequate representation of skillsets that are aligned to the earlier phases of project development (i.e., research, development, design, requirements definition and system of systems). Additionally, a significant portion of our projects does not align with our technical priority areas. Application of this technology strategy will allow us to shape our work effort and apply our technical resources much earlier in the engineering life cycle.

Assertion of Technology Growth Areas in Technical Execution

It is important to note that the technology strategy's focus is on the development and continual evolution in defining and governing our core advanced technology direction, and guiding the investments we make and work we take in those areas. Defining, implementing, and technical sustainment of engineering execution processes, skillsets and infrastructure (e.g., system of systems engineering, sharing of design patterns and best practices) is part of existing technical execution governance and steering committees that will govern our processes and command business IT. The Technical Execution Steering Committee (TESC) will engage with these efforts to ensure the TGAs are managed appropriately, and fully integrated into the command communities.

Communication Strategy

Deliberate communications strategy will be developed and maintained to best achieve an awareness, understanding, acceptance and use of the technology strategy.

Briefings and Presentations

This technology strategy will be regularly communicated across leadership and the workforce using the various venues available to the business board and its steering committees. The TESC will develop and be responsible for shaping this communications messaging and ensuring all leadership is aware, understands, and can present the general concepts and goals that this strategy prescribes. The TESC will also develop appropriate briefings internal and external to the command as directed by the Commanding Officer/Executive Director, providing awareness of intent, progress, challenges, and successes resulting from this strategy's intent.

Risk Mitigation & Metrics

A significant component of the delegation of the business board strategies to its various steering committees is the acceptance and use of metrics and thresholds to aid expectation management and assessment of progress. The TESC, with support of other steering committees where appropriate, will develop, measure, and maintain measures of effectiveness and performance metrics and will create and maintain a scorecard to be used in business board reviews and as communication to larger internal, DoD, and external audiences.

The technology strategy encourages concepts and approaches that will challenge existing practices in the command. To ensure a culture shift is achieved, a number of factors must be considered to mitigate risk appropriately. A number of assessments will be conducted and monitored such as:

- Alignment and justification of SSC Atlantic technical priorities against naval needs
- Allocation of discretionary funding against TGAs and other technical command goals
- New project acceptance in planned focus areas
- Utilized skillsets in planned focus areas
- Laboratory use and quality

Appendix

SSC Atlantic Science and Technology (S&T) Program

As command priorities shift to include improved capability and delivery in TGAs, we must leverage our research and development program to lean forward, create new opportunities, and build expertise in emerging areas not yet supported through current portfolio demands. Improving skills and capability in new technical areas will enable portfolios to broaden their sponsor relationships and create new business opportunities, enabling the shaping of work toward our TGA goals.

By the very nature of discovery and the exploration of new concepts, many research initiatives seeded today will execute a multiyear development program as concepts migrate through the scientific process and increasing levels of technology readiness. The goal of the SSC Atlantic S&T program is to identify and seed relevant technology development, workforce skills, and laboratory capability that is aligned to and advances our capability relevant to the technology strategy. Additionally, in a sequestration environment and aligned to Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (OUSD(AT&L)) and Deputy Assistant Secretary of the Navy for Research Development Test and Evaluation (DASN/RDT&E) directives, the SSC Atlantic S&T program must move technologies specific to our domain forward, with the goal of demonstrating, prototyping and creating future buying options for our sponsors.

Many research efforts, and the skillsets required to execute them, generally have multiple potential applications. As a result, and by design, this creates a one-to-many relationship between a research area and multiple TGAs. An example of this is shown below (figure 3).

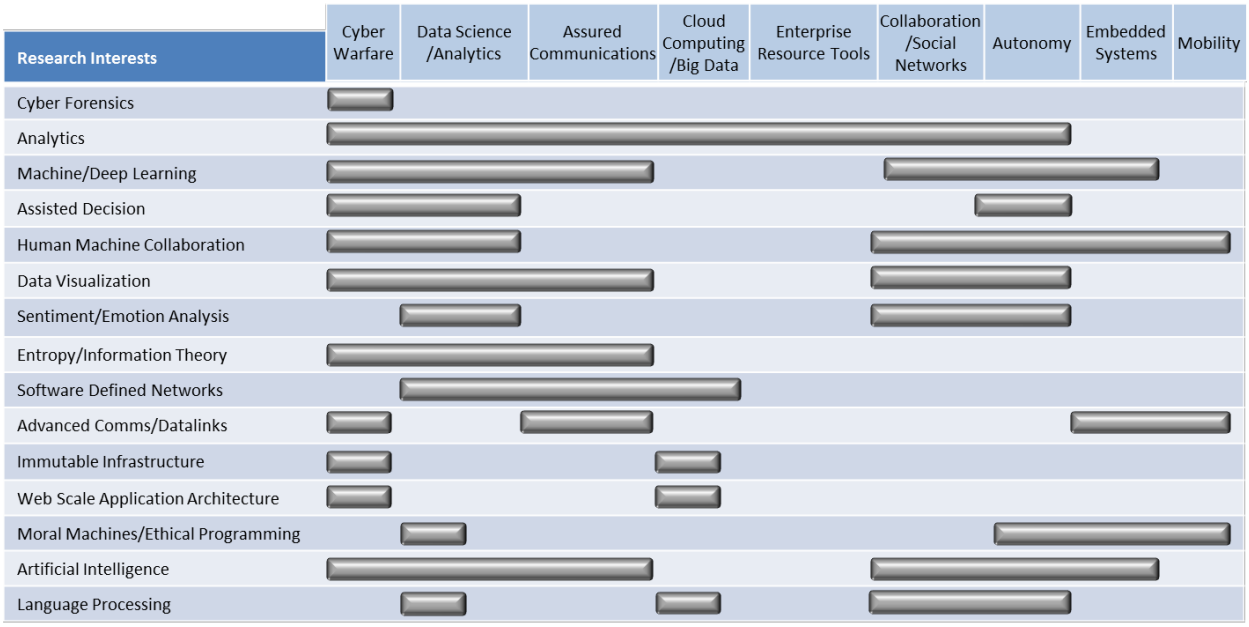

Figure 3: SSC Atlantic Research Initiatives Relative to Multiple Technology Growth Areas

While portfolio thrust areas continue to mature, this relationship will likely hold true as well when mapping a research area to portfolio thrusts.

In support of DASN/RDT&E, an effort is underway to increase awareness and alignment across the naval research program beyond 5 years. A sample of SSC Atlantic initiatives and their alignment to TGAs are shown in figure 4.

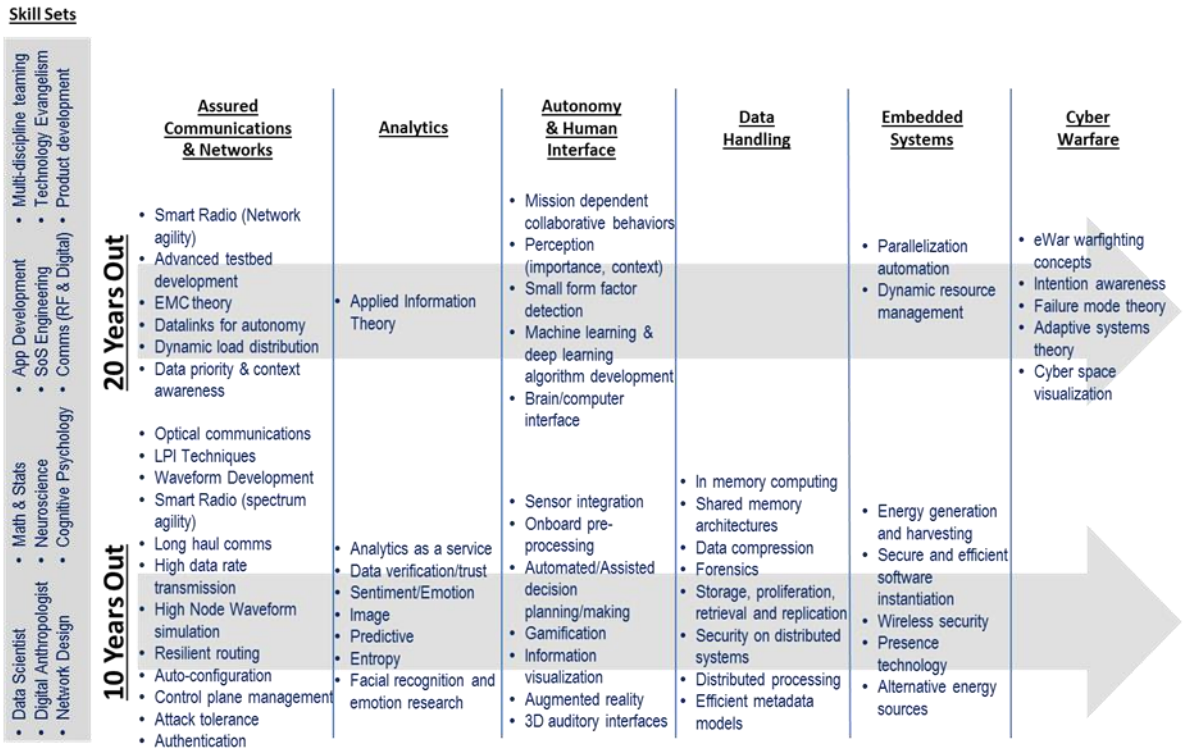

Figure 4: Future SSC Atlantic S&T Focus Areas' Alignment to NR&DE 30-Year Plan